

WHAT IS CLAIMED IS:

1. A polymer electrolyte fuel cell including a high-temperature portion and a low-temperature portion in a cell plane, said fuel cell comprising:

an oxidant gas passage formed in said fuel cell,

5 wherein an oxidant gas flow is directed from said high-temperature portion to said low-temperature portion of the fuel cell so that water produced during operation of the fuel cell recirculates in said oxidant gas passage.

2. A fuel cell according to claim 1, wherein said low-temperature portion is
10 located at a higher position than said high-temperature portion.

3. A fuel cell according to claim 1, wherein said oxidant gas flow direction is reverse to a direction of gravity.

15 4. A fuel cell according to claim 1, wherein said oxidant gas passage includes an upstream portion and a downstream portion, said upstream portion of said oxidant gas passage being provided with a hydrophilicity-treated portion, and said downstream portion of said oxidant gas passage being provided with a hydrophobicity-treated portion.

20 5. A fuel cell according to claim 1, wherein said oxidant gas passage includes an upstream portion and a downstream portion, said downstream portion of said oxidant gas passage being provided with a hydrophobicity-treated portion, and further comprising a water drop atomizing device disposed at a location upstream of
25 an inlet of said oxidant gas passage.

6. A fuel cell according to claim 4 or claim 5, wherein said hydrophobicity-

treated portion provided to said downstream portion of said oxidant gas passage includes a fluororesin coating formed at a surface of said downstream portion of said oxidant gas passage.

5 7. A fuel cell according to claim 4, wherein said hydrophilicity-treated portion provided to said upstream portion of said oxidant gas passage includes a silicon dioxide layer formed at a surface of said upstream portion of said oxidant gas passage.

10 8. A fuel cell according to claim 1, further comprising:
a fuel gas passage formed in said fuel cell,
wherein a fuel gas flow is directed from said high-temperature portion to said low-temperature portion.

15 9. A fuel cell according to claim 1, further comprising:
a fuel gas passage formed in said fuel cell, said fuel gas passage including a fuel gas inlet to the cell and a fuel gas outlet from the cell,
wherein a fuel gas flow is directed from said low-temperature portion to said high-temperature portion, and said fuel gas outlet is positioned lower than said fuel
20 gas inlet.

10. A fuel cell according to claim 1, wherein a self-humidification of the cell is conducted due to the recirculation of a product water in said oxidant gas passage.